HUNTOON

Concrete Posts & Poles

Civil Engineering
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CONCRETE POSTS AND POLES

BY

JOHN SAMUELS HUNTOON

THESIS

FOR

DEGREE OF BACHELOR OF SCIENCE

IN

CIVIL ENGINEERING

COLLEGE OF ENGINEERING

UNIVERSITY OF ILLINOIS

PRESENTED JUNE 1905

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May 15, 1905

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OF Bachelor of Science in Civil Engineering

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CONCRETE POSTS AND POLES

Our forests are rapidly being cut off and consequently good timber is increasing in price and decreasing in quality. Further, this process is likely to continue in the future at an accelerated rate; and therefore there is a great incentive to find substitutes for timber. There has been considerable discussion in the last decade or two as to some source of supply for railroad ties for the future; but no satisfactory solution seems to have yet been discovered. One of the comparatively minor uses for timber, and yet one by no means small in itself, is fence

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posts, telephone poles; and within a year or two several propositions have been made to use concrete for these purposes. This being the case, the writer decided to choose as his thesis an investigation of the possibility of substituting some form of concrete construction for fence posts, poles for electric light and electric railroads, telephones, etc.

Concrete posts are made with, and without reinforcement. Concrete posts without reinforcement are weak in flexure, and are seldom used except where the cross section is necessarily very large. Metal reinforcement does not cost much, and either adds greatly to the strength of the post or saves considerable material in its

construction; and the writer thinks that all concrete posts, telephone poles, railroad ties, etc., should contain some form of metal reinforcement to give them strength to resist flexure, shifting, and mishandling. The only reinforced concrete posts and poles will be considered in this article. The subject will be discussed further under the following heads:

Part I, Posts for Use on Railroads.

Part II, Fence Posts.

Part III, Telephone and Telegraph Poles, etc.

PART I. POSTS FOR USE ON RAILROADS

Within recent years there has become a tendency to replace timber structures by more permanent ones, and this tendency is particularly marked on some of our large railroads, where wooden trestles, right-of-way posts, whistle posts, and other forms of wooden marks are being replaced by reinforced concrete. Among the first railways thus to use concrete was the Chicago and Eastern Illinois Ry., and the Peoria & Eastern Ry.

Chicago and Eastern Illinois Standards

The Chicago and Eastern Illinois Railway in December, 1904

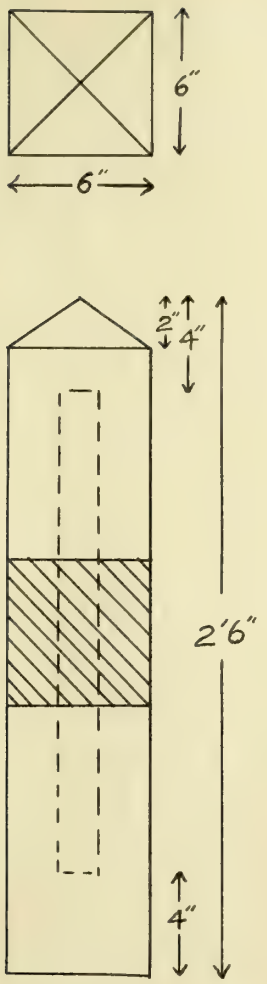
adopted standard concrete for the following purposes, viz.:

Curbing for highways, roadways, location of property lines, and small fills.

The posts are square or approximately triangular in cross-section, and vary in length from two feet six inches to eight feet six inches. Four forms of metal reinforcement are used, viz.: (1) three-quarter-inch scrap-iron gas-pipe, (2) old two-inch boiler flues, (3) one-half by one-inch corrugated iron bar, and (4) four No. 9 iron wires. The detail drawings of these posts are shown on Plates I, II, III and IV.

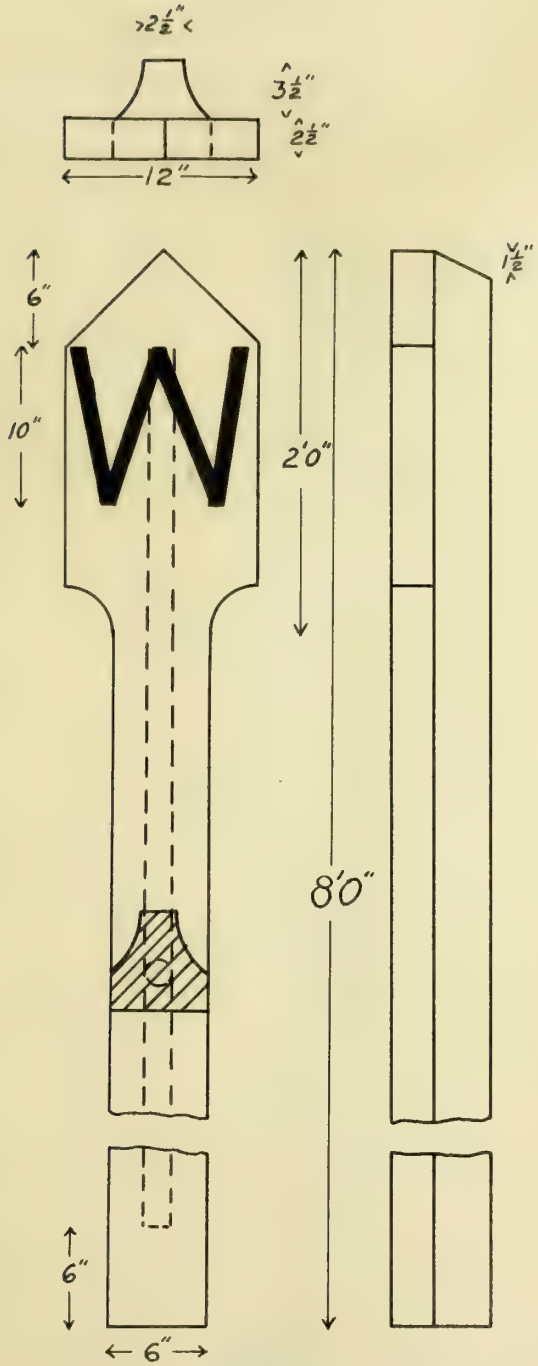
The concrete consisted of a mixture of one part of Atlas Steel Company's Universal Portland cement to five parts of clean sharp gravel.

PLATE I.

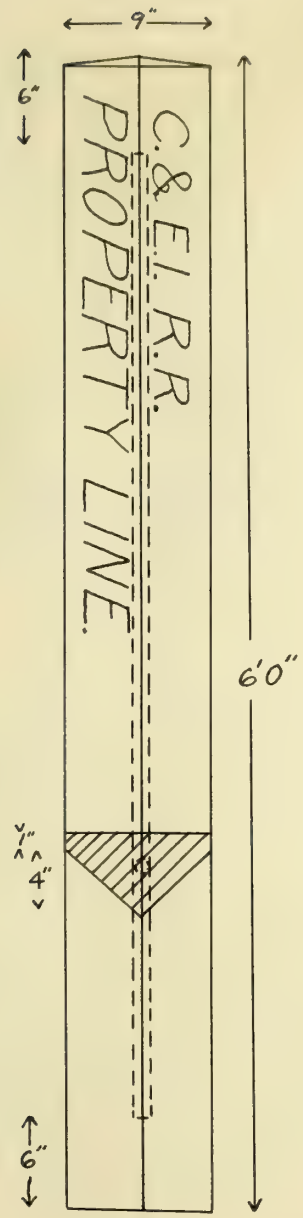


Clearance Post
C & E.I. Standard

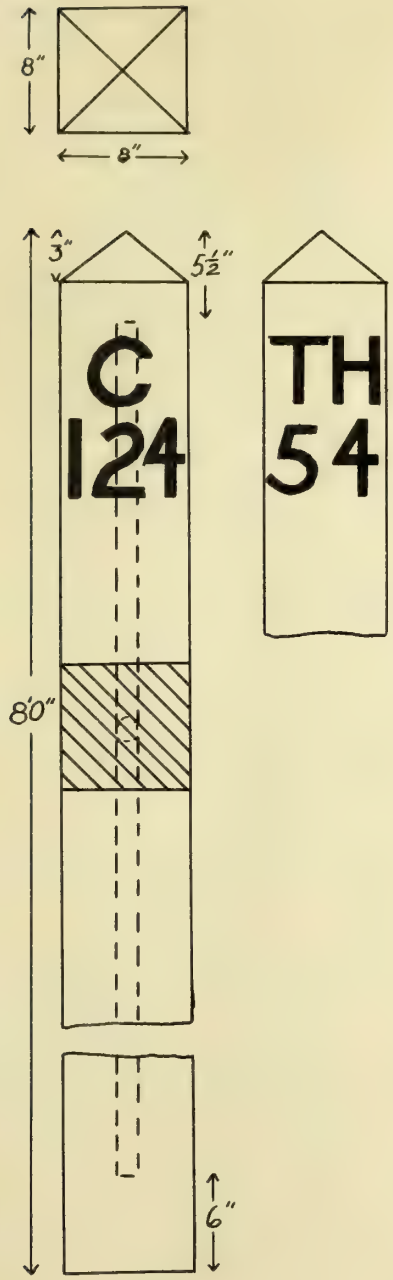
PLATE II



Whistle Post For
Highway Crossings
C & E.I. Standard



Property Line Post
C. & E. I. Standard



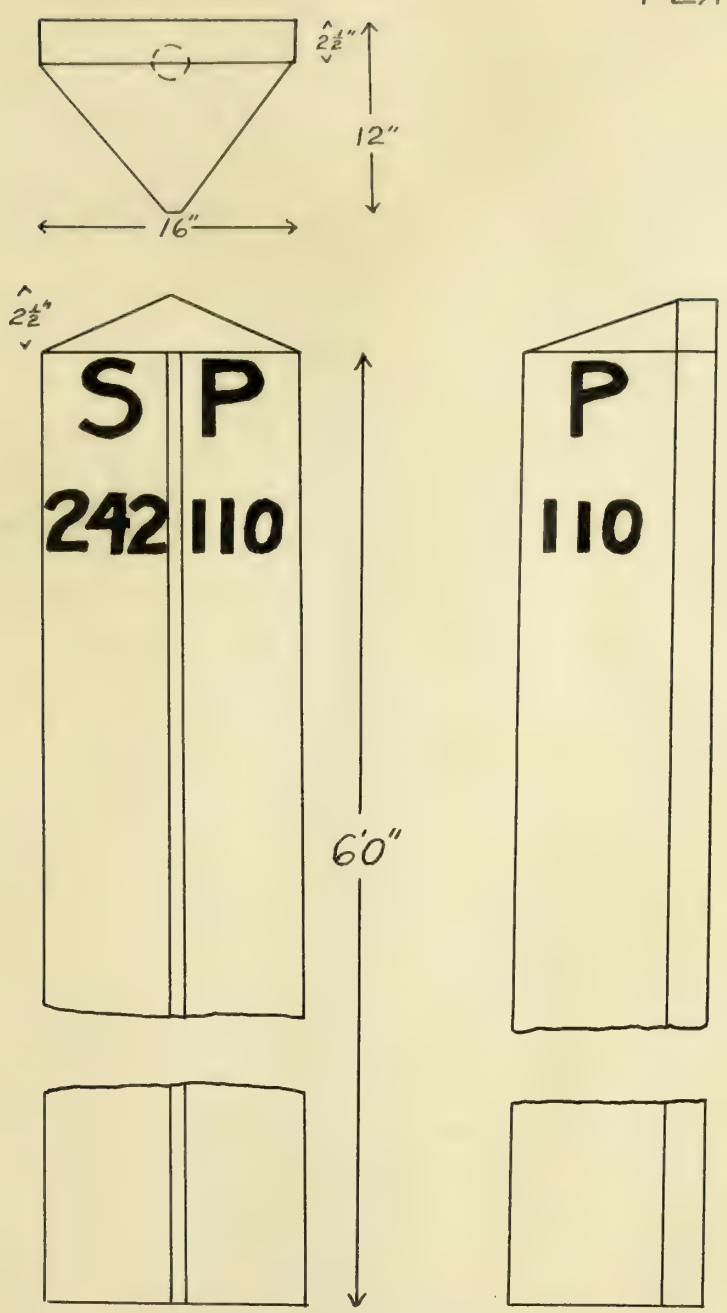
Mile Post
C & E.I. Standard

Peoria & Eastern Standards

The Peoria and Eastern Railway, a line of the Cincinnati, Cleveland, Chicago, and St Louis Railway System, in 1903, adopted standard concrete posts for various purposes, such as mile posts, clearance, and location of property lines. The height, cross-sections of the posts, are square or approximately triangular, the area of which varies from sixteen to one hundred and sixteen square inches. The reinforcement is scrap iron or pipe, or old boiler flues. The detail drawings of these posts are shown on Plates V, VI, and VII.

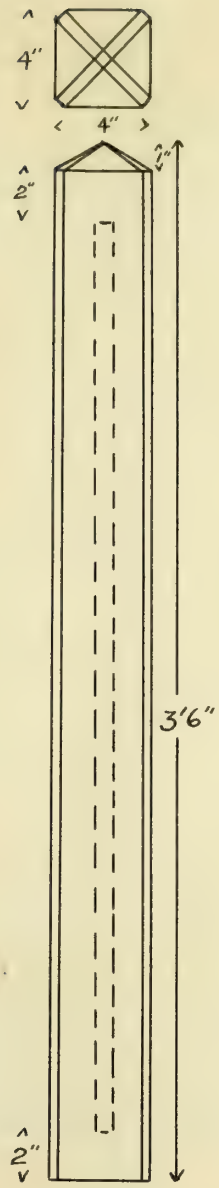
These posts are made of concrete

PLATE V

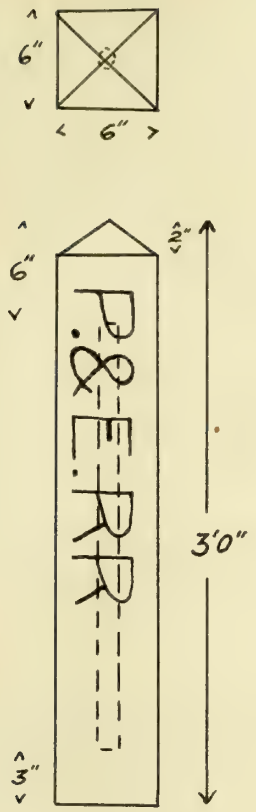


Mile Post
P. & E. Standard

PLATE VI



Clearance Post
P. & E. Standard



Property Line Post
P.&E. Standard

and in proportions of cement and sand suitable for different kinds of work. The mixtures are made from a mixture of one part of cement to six parts of gravel; the common fence posts are made of one part of cement, two parts of sand and two parts of stone screenings.

PART II FENCE POSTS

Wood has always been used as a material for posts, and probably will continue to be used for this purpose until some other form of construction becomes more economical. Wooden posts have some advantages. Their first cost is small as compared with the cost of other

materials, as steel or stone. Another advantage is that the boards can be easily fastened to them.

Steel posts have a number of disadvantages. They are short lived, lasting only from five to seven years, and as we use the first cost is high. Taking the first cost of a cedar post at 25 cents, the annual cost would vary from 3 cts to 5 cts per year. This price does not include the expense of setting or of fastening the boards or wire to it. Further, wooden posts are becoming more expensive as the forests are being cut off. The supply of good timber is already practically exhausted, and upland cedar is getting very scarce, the present supply of cedar

[illegible] and most of these posts have the bark rotted away. The above shows the desirability, or rather the necessity, of obtaining a substitute for wood fence posts.

Concrete Posts

Concrete fence posts have several advantages over wooden ones. The former will not decay; and ought to last as long as the Pyramids of Egypt, since they are made of similar material. Further, cement improves with age, and consequently the posts become stronger the longer they are exposed to the weather. Another advantage of concrete posts is that they are not damaged by fire; and therefore fires can burn weeds, cornstalks, and

fence is adjacent to the fence and thus
danger of destroying his fences. Again,
connections can be made so that
lightning will not affect them,
which is accomplished by connecting
metal reinforcement to the ground.
This construction has the further ad-
vantage that the electricity is conducted
from the fence wire to the ground, and
hence is not liable to pass through the
wire and possibly kill stock that may
be huddled near the fence. See Fig. 1
The report of one hundred co-operative
insurance companies, made at their an-
nual meeting in Des Moines, Iowa,
in 1902 shows over seventy-five per cent
of their losses were caused by lightning,
of which seventy per cent was on
live stock, or of their total losses fif-

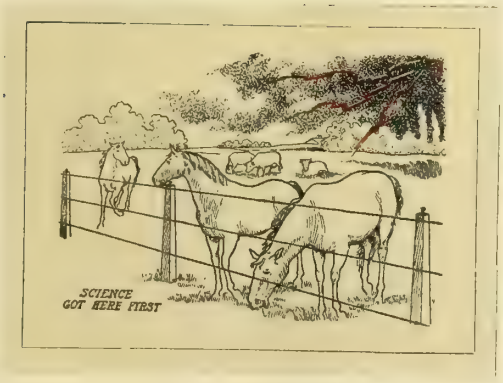
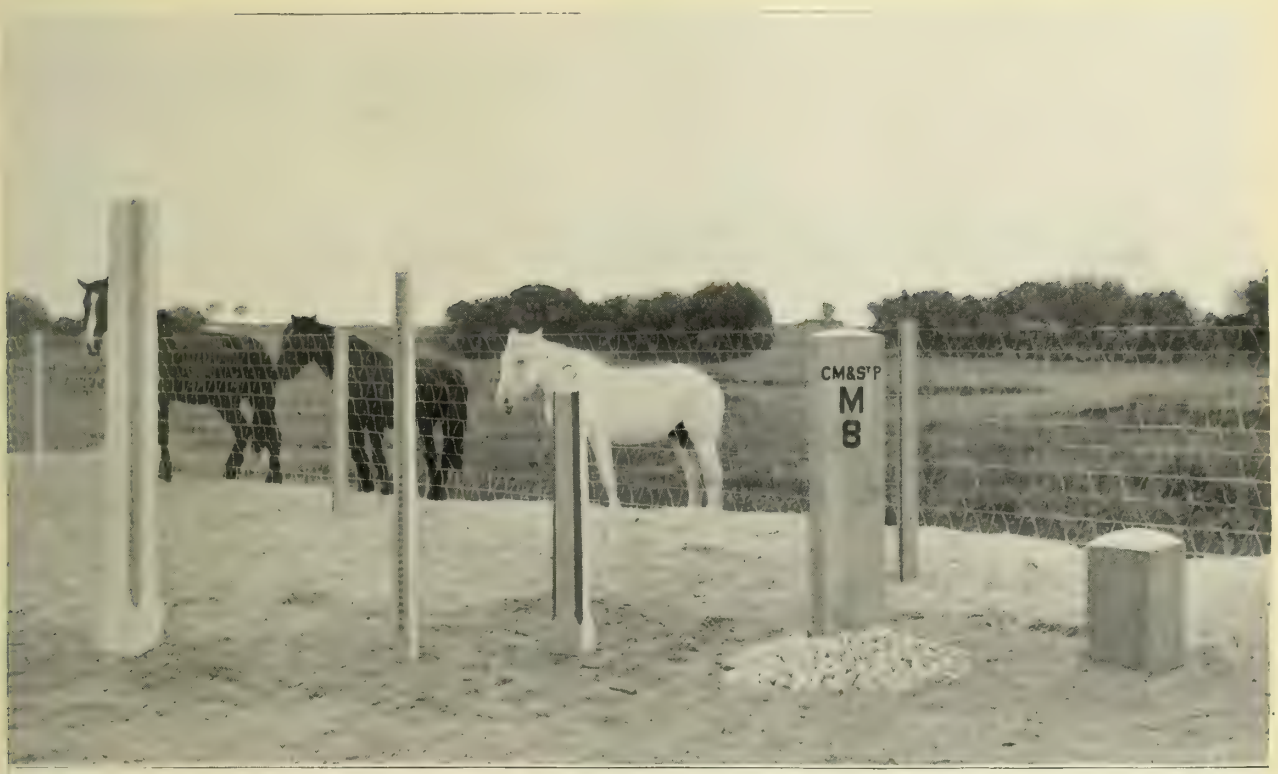


Fig. 1

one and one-half feet would rather be
liable to be killed by lightning.

There are two different kinds
of posts constructed for fence purposes, corner posts and line posts - see Fig 2. The former are larger than the latter, and contain more reinforcement. The horizontal cross section of the corner posts varies from five to six inches square, and have the corners slightly chamfered. The posts vary in length from seven feet six inches to eight feet six inches. Some manufacturers make the line posts with a square horizontal cross section; and others give them a rectangular cross section, in which case the small dimension is placed parallel to the direction of the fence. Others still manufacture a quasi cross sec-



CORNER POST. LINE POST. HITCHING POST. MILE POST. CEMETERY POST.

Fig. 2

to the corner posts, which are usually about six inches square at the bottom and taper to about five inches square at the top. The line posts are about four inches square at the bottom, shaped like a rectangle, whose sides are three and five inches, and taper slightly to the top. Some manufacturers insert a staple in each corner of their post, while others place an angle staple in each side of the post.

A number of methods have been used to fasten the boards and wire to the fence, viz: (1) By crossing the wire around the post and the line wire. - see Fig. 3. This fastening does not make a great appearance, and if the tie wire is not twisted tight

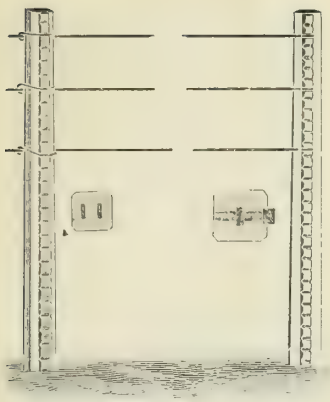


Fig. 3.

the line of the joist by driving a nail at each end. (2) By screwing the timber through to the holes provided in the face of the joist. This method of fastening is objectionable because it diminishes the horizontal cross section and decreases the strength of the joist. Another objection to this fastening is that barbed wire cannot be pulled through the holes unless they are made very large.

(3) By fastening wooden cleats embedded in the concrete to which the wood boards are fastened by staples. This method of fastening is objectionable, since the wood will swell and crack the concrete before it sets; and further since water is likely to get between the wood and the concrete, and thus

stimulate decay. (4) By bolting wooden cleats to the face of the joist to which the boards are nailed or stapled. -see Fig. 4. A cast iron washer is placed between the joist and the cleat, which allows the air to circulate and keep the wood from decaying. This method is used by a number of manufacturers, and is considered very economical. (5) Fastening by two staples, one above the other with the legs in the horizontal plane and the legs embedded in the concrete, the wire being fastened between the staples by a retaining pin inserted through the loops. -see Fig. 5. This is a very convenient method of fastening barbed or woven wire to concrete posts. This fastening is used by the Electric

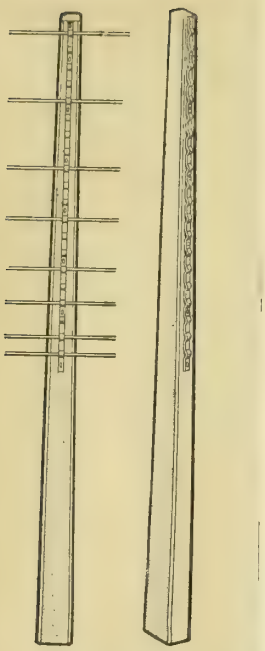
Fig 4.

Fig. 5

Concrete Post Company of Lake City, Iowa. (6) Fastening by strips of galvanized iron with numerous horizontal corrugations, the wire being threaded through one the loops. - See Fig. 9. The corrugated iron strip is fastened to the post either by bolts or staples embedded in the concrete. One advantage of this fastening is that the corrugations are very close, which permits the wires to be spaced at any required distance apart.

Cost of Concrete Posts

Concrete posts are usually sold f.o.b. the factory, and when freight charges are such as to prohibit the manufacturer selling to the farmer the tools and the right to manufacture posts for his own use, or to sell in



SHOWING CORRUGATED STRIP ON POST AND METHOD OF FASTENING WIRE.

Fig. 6

a certain locality. The agents of the Evansville Cement Post Co., Evansville, Wisconsin, for carload lots f.o.b. factory are:

Line posts $12.50 per hundred

Corner posts $22.00 " "

Some patentees do not manufacture concrete posts but sell the exclusive right to make them for use in special localities. Mr. C. Platten-berger of Savanna, Illinois, sells the exclusive right to manufacture and sell posts in a township for sixteen dollars; and the exclusive right to manufacture and sell in a county for thirty three dollars.

Tests of Fence Posts

One of the requisites for a good fence, post is that it shall be of

sufficient strength to resist the
stresses due to stabbing them
to the rubbing of stock, or to blow-
ways or fires, etc. It is impossible to
determine with any considerable ac-
curacy what these forces will be, and
therefore it is only possible to compare
the strength of concrete posts with
wooden ones that have successfully
stood actual service. Since cedar
posts have withstood the above require-
ment, the writer decided to test a number
of them, and also to test a number
of concrete posts under similar conditions.

Both kinds of posts were tested
as beams resting on end posts as per
cut, the load being applied in the
middle. The cedar posts were purchased
from the stock of H. F. Walls Company

Champaign, Illinois. The results of these tests are shown in Table I

Table I.

Strength Of Cedar Fence Posts

Ref No.	Diameter in inches		Ultimate Breaking Force in lbs.
	Small End	Large End	
1	5	7	6300
2	6	7	7350
3	6	7	5600
4	5½	6½	6000
5	5	6½	6800
6	5¼	7	6700
Average breaking force			6460

The concrete posts were obtained from J. F. Plattenberger, Swansea, Illinois, and the Janesville Cement Post Co., Janesville, Wisconsin. The concrete in the former posts was of an excellent

quality, its fracture being one just of Portland cement to these fences found. These posts were reinforced by metal rods one quarter inch in diameter; but the reinforcement was unscientifically placed. Fig. 7 to 11 inclusive show the form of cross section and the location of metal reinforcement at the breaking section of four posts which were tested to destruction. The faulty location of the metal is especially marked in Fig. 7, which has the metal very close to the neutral axis. Such a position of the metal gives but little resistance except to the pull on the wire in the direction of the fence, which is always quite small. Further, the metal itself has a very low elastic limit; and, consequently elongates under a small

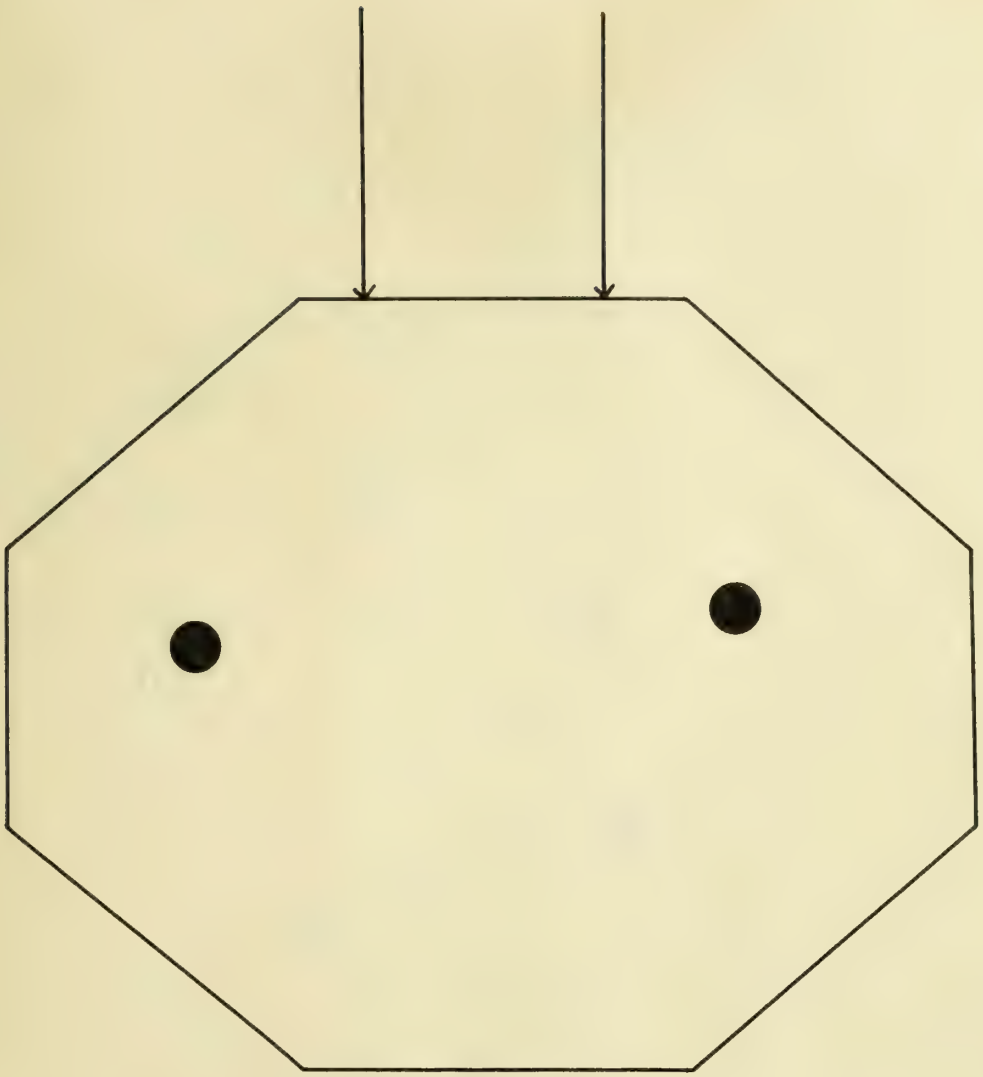


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Fig. 7.

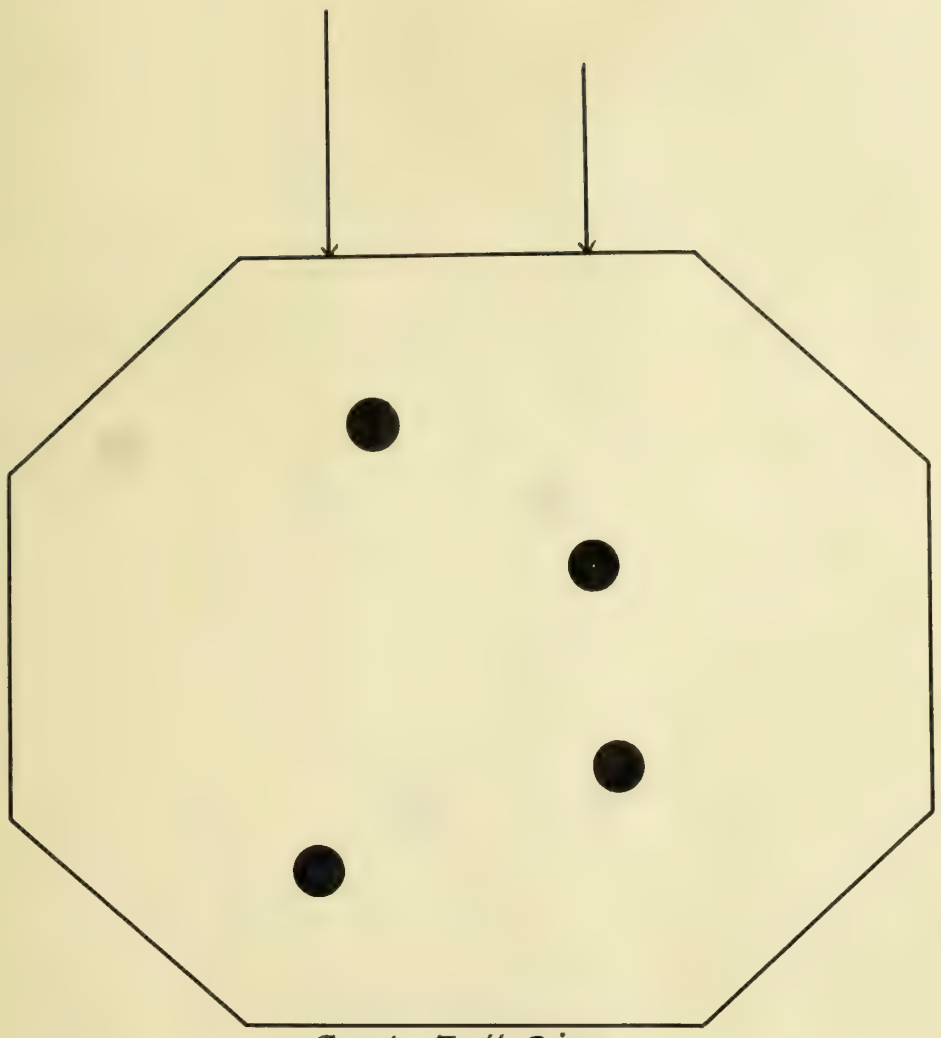

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Fig. 8.

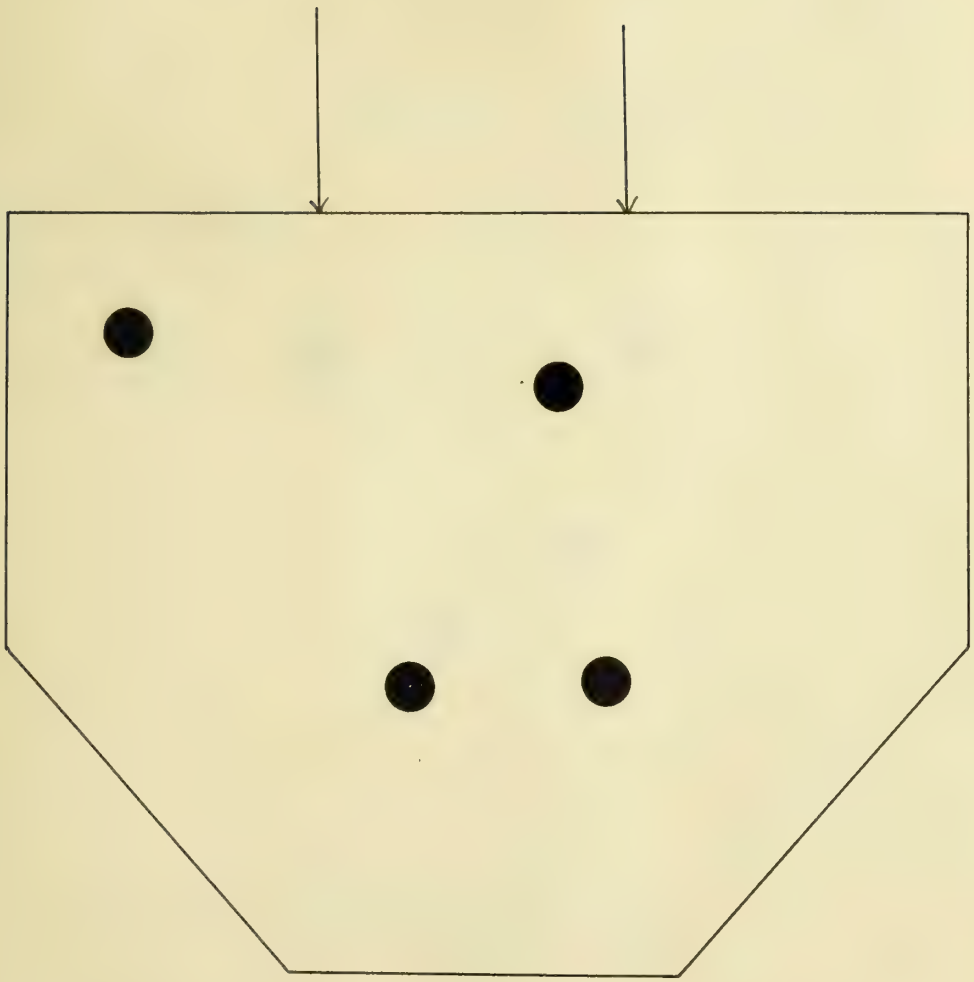

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Fig. 9.

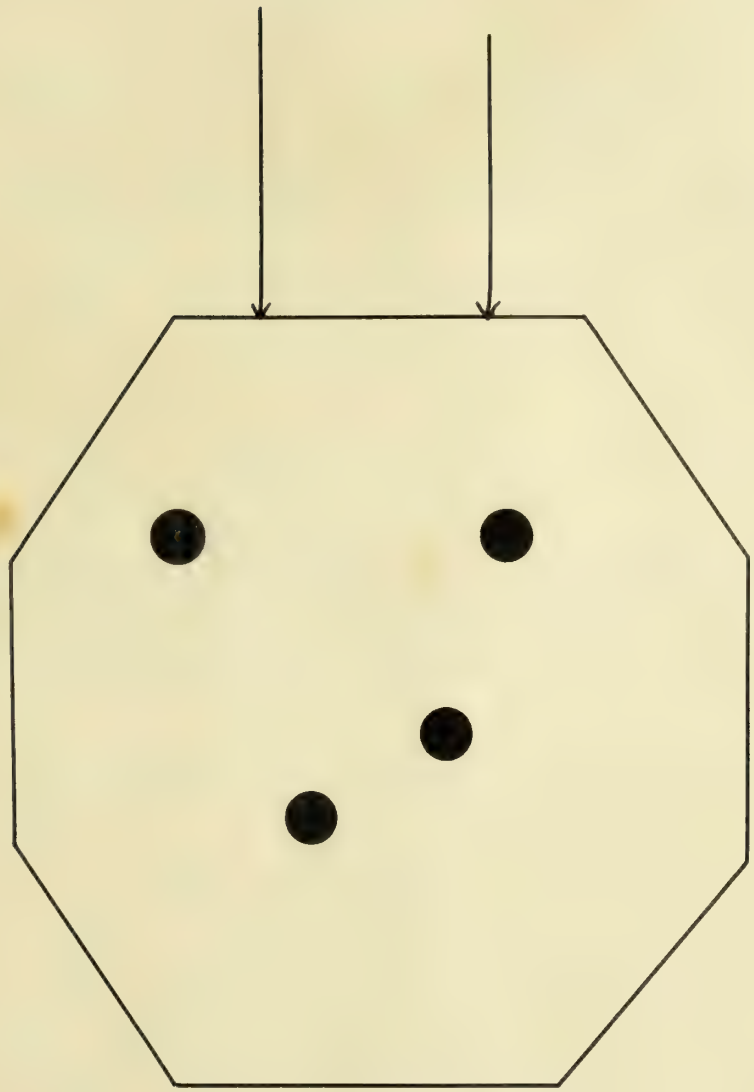

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Fig. 10

[illegible] wires, which cause cracks on the underside of the beam.

The efficiency of the reinforcement of this post will be considered later.

Table II.

Strength Of Reinforced Concrete Fence Posts

Ref. No	For Cross Section Of Post See	Breaking Load In Pounds	Deflection in Inches.
1	Fig. 10	460	0.5
2	Fig. 7	275	0.51
3	Fig. 9	970	0.62
4	Fig. 8	820	0.87

[illegible] of the Concrete-Steel Co., of Pittsburg, and consequently the writer decided to use the light-reinforced beams of the manufacture of the Concrete Steel Co., Pittsburg, Pa. These beams were tested under concentrated loads to failure for the purpose of the results of which are shown in Table I. The first failed under a load of 630 lbs., and the second under a load of 610 lbs. The reinforcement consisted of six soft steel bars twisted together in pairs. The section of the steel at the breaking section is shown in Fig. 11.

The arrangement of the reinforcement in this beam is specially objectionable because it is not symmet-

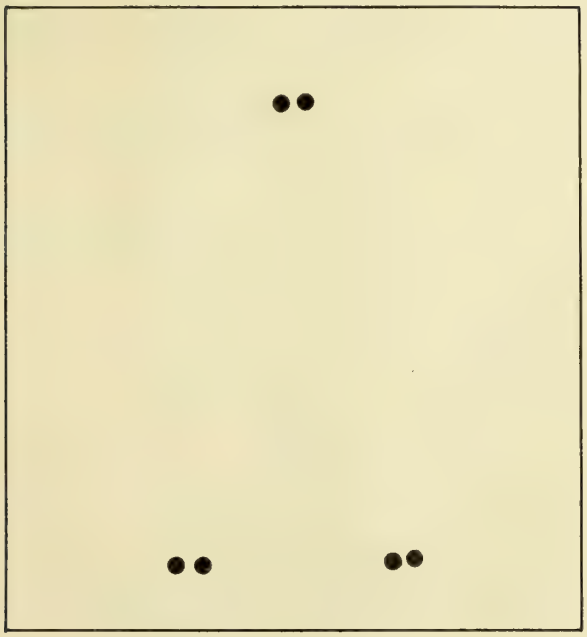

Fig 11.

scale with respect to the [illegible] axis, which gives a greater resistance in one direction than in the other.

Conclusion

In order that the post may be as economical as possible, the writer would advise that instead of making the cross sections shown in Fig. 7 to 11 inclusive it be modified as follows: (1) the cross section of the post should be changed to a rectangle about five inches long and three inches wide, the short side of the rectangle being placed parallel to the fence; (2) the metal should be placed parallel to, and about three eighths of an inch from, the narrow face of the post and about one half inch from the broad face

Fig 12

see Fig. 2. (2) the metal should consist of a number of comparatively small wires instead of one or two comparatively large rods. (3) the metal should have as high an elastic limit as possible; and (4) the cross section of the reinforcement should be of such size and so distributed as to best fit the area of the cross section of the concrete.†

† Test of reinforced concrete beams (Bulletin Vol of the University of Illinois p. 54

PART III CONCRETE POLES AND BUTTS

Concrete Poles

In Part I, the writer endeavored to show some of the reasons for the desire to substitute concrete for wood as a material for posts. Since telephone poles, street railway poles, and telegraph poles are subject to decaying influences similar to those which affect fence posts, it has been suggested that concrete be used in place of wood as a material for such poles.

Poles made of concrete would have the disadvantage of being weak in flexure, and hence heavy metal reinforcement would be necessary to enable them to resist the strains due to pull on

the wire, and also to avoid a danger which
existing the pole. Owing, however, to
the more than twenty-five feet would
be very heavy, and probably a derrick
would be required to raise them. Further,
concrete poles could not be unloaded
from a moving train without breaking
them, which would increase the cost of
building lines.

The principal advantage to be
derived from the use of concrete poles
is that they are permanent construction
and will last materially forever. Another
advantage, and by no means the least
important, is that concrete poles do not
need painting.

The writer thinks that concrete
poles should should not be used by
street railways or telephone and telegraph

conductors within the city limits, from
the former case the cross section of
poles would be necessarily very large to
resist the strain due to vibration of the bare
wire, and in the latter case cities or towns
usually require all telephone, telegraph and
electric light poles to be over thirty feet long,
a length impracticable for concrete poles.

The writer believes concrete poles
not exceeding twenty-five feet in length,
could be economically used for long
distance telephone and telegraph purposes
along country highways, since the wires
being few the stress on each pole would
not be excessive. Further, they would
not be subjected to suddenly applied
forces from wagon wheels and runaways
which are liable to occur in cities.

Concrete Butts

Since telephone and telegraph poles decaying in a space either six inches above or six inches below the ground line, it has been suggested that concrete be substituted for the decayed wooden butt of the pole.

It is very expensive to set poles and re-string wires. Part of this expense can be avoided by sawing off the old pole at the top of the ground, and pushing the pole a few feet to one side, so that the rotten butt may be removed and a concrete base set in its place. The concrete butt may be fastened to the pole by iron bars imbeded in the cement and bolted to the pole.

The only objection to the above

method of repairing poles is that water is liable to get between the wood and the concete; but this may be easily overcome by making a water-tight seal with asphalt or paint.

J. S. Huntoon

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